

# BOTANICAL GAZETTE

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*FEBRUARY 1897*

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## OPPORTUNITIES FOR RESEARCH IN BOTANY OFFERED BY AMERICAN INSTITUTIONS.

ELEVEN years ago the GAZETTE published what was called a "laboratory number," in which were described the facilities of some of the institutions which had equipped laboratories for instruction in elementary botany. Within the last decade a considerable number have not only provided for elementary work but also for the advanced work and research leading to a doctor's degree.

In conversation with two of the editors of the GAZETTE last summer, Professor MacDougal suggested that it would be of advantage to botanists for the editors to bring together a statement of the opportunities for research now afforded by American laboratories. To present an absolutely complete statement of this kind is obviously an almost impossible task, since there is no sharp line between research in pure and applied botany, and there are many advantages for original research in connection with the agricultural experiment stations. It seemed best, therefore, to limit the present account to the institutions conferring a doctor's degree. This excludes such important institutions as the National Herbarium, the Missouri Botanic Garden, and others, whose extensive libraries and collections are freely open to all qualified students.

The degree Ph.D., or Sc.D., is conferred by the institutions represented in the following pages only in recognition of capac-



ity for original research as shown by a thesis approved by the faculty. A residence of at least one year, and in some cases two years, at the university conferring the degree is required. Upon the presentation of a satisfactory thesis the candidate is admitted to examination, which must show familiarity with the general subject of botany, and in most institutions with one or two allied subjects as minors. Usually no precise requirements are stated, but the minimum time in most institutions is three years of graduate work.

In order to elicit the information desired the editors of the GAZETTE selected seventeen institutions where they personally knew of the existence of well equipped laboratories and a vigorous head of the botanical department. To the head of the department was addressed a letter of inquiry, in which, to guard against misunderstanding, the following language was used:

We wish to know what work in botany a student can obtain in your institution this year, who should come with three years of training in general botany and ask to enter for the doctor's degree. This information is intended not for the glorification of any university, but to give the actual status of the facilities for graduate work in American laboratories. It is not intended to give what the instructor might do had he more time, a better library, and more apparatus, but what he can do actually with his present limitations. This is making an unusual demand upon your time, but we are confident that you will aid us in making this statement as full and accurate as possible.

In order that no essential point may be omitted we would suggest that not only the kind of work that is possible be described, but definite information given as to strength of library and collections, and also garden and greenhouse facilities. We shall take it for granted that the ordinary appliances are available.

Replies were received from all those addressed. Two of the seventeen replied that the institution did not offer the doctor's degree in botany at present. The reply from another stated no subjects in which research might be undertaken, so that it was not possible to include it in the summary given below. In addition to the information conveyed by letter we have used data derived from the handbook for graduate students, *Graduate Courses*, for 1896-7, and from the catalogues of the several institutions. All the data obtained have been arranged under



the headings: staff; subjects offered; library; greenhouses and garden; collections; publication; remarks.

In giving the "staff" we have included all those concerned in instruction, so far as known to us, in order to indicate something of the strength of the department. For the same purpose we have also stated the number of volumes in the general library. While botanical works bear no necessary ratio to the whole, this furnishes a datum for estimate and for interpretation of the statements regarding the botanical library. In some cases the number of botanical works is stated, which is most direct and satisfactory.

It will be understood that under "subjects offered" are listed those divisions of botany within which the staff may be considered competent to suggest problems for research, and for which suitable facilities are now at hand. No account is taken here of any courses of instruction, whether offered to graduates or to undergraduates, though these may be an important factor in preparation for the examination.

Channels for publication are abundant; but certain institutions have journals or bulletins which are especially established to receive the results of research prosecuted at them. In such cases these have been indicated under the heading "publication."

In the following pages the institutions are arranged alphabetically. As far as possible the statements are given in the words of the writers.

#### UNIVERSITY OF CALIFORNIA.

*Staff.*—William A. Setchell, Ph.D., Professor; W. L. Jepson, Ph.B., Instructor; W. J. V. Osterhout, A.M., Instructor; J. Burtt Davy, Assistant in the Botanic Garden; C. P. Nott, Ph.B., Graduate Assistant.

*Subjects offered.*—CRYPTOGAMIC BOTANY. The cryptogams of California offer exceptional opportunities for research, and many simpler problems are presented for original investigation. This work will be confined, during the year 1896-7, almost exclu-



sively to the algæ, in connection with the special work of the instructor.—Professor SETCHELL.

PHÆNOGAMIC BOTANY. Special problems requiring the original investigation of some particular order or smaller group of flowering plants. Work in the field as well as in the laboratory required.—Mr. JEPSON.

HISTOLOGY AND CYTOLOGY. Special problems in histology or cytology.—Mr. OSTERHOUT.

*Library.*—In the university library (65,000 volumes, 32,000 pamphlets) and that of the Academy of Sciences in San Francisco (nine miles away but readily accessible for a small fare) the important botanical works and periodicals are fairly well represented. For systematic work upon phænogams, and upon certain groups of cryptogams the literature is fairly complete. The works upon cytology are also well represented. There is some considerable representation of works upon vegetable histology and physiology.

*Greenhouses and garden.*—The new conservatory, recently completed, is a structure of iron and glass, and embodies the latest improvements; extreme length 170 feet, greatest width 60 feet, area about 7000 square feet; five subdivisions arranged for different temperatures. Especially for use of Agricultural Department.

The botanical garden occupies about seven acres of ground, of which about four have been laid out into garden plots. The remaining acres are in various degrees of preparation, but have already been planted with different shrubs and young trees. Altogether there are growing in the garden about 1500 species of plants, of which 1000 are perennial species and well established. About 1000 of these are Californian. Besides these there is a collection of seeds of about 2000 species, the greater part of them native. The plants of many different climates grow well out of doors. The collections of Australian, Chilian, Japanese, Chinese, African, and European species in common cultivation upon the university grounds and in the garden of useful plants of the Agricultural Department afford a rare opportunity for obtaining material.



*Collections.*—The herbarium of the university has been gathered by gifts and purchases around the nucleus of about a thousand species contributed by the State Geological Survey. The number of sheets now amounts to over 20,000 and there is sufficient unmounted material, which is being cared for as rapidly as the facilities will permit, to bring the number up to nearly 30,000. About two-thirds of these are given up to North American species. The remaining third is divided among the species of South America, Asia, Africa, Europe, and Oceanica.

The cryptogamic side of the herbarium has of late been especially developed, and already contains about 4000 specimens of ferns, mosses, hepatics, marine algæ, fungi, etc. The valuable collections of algæ, fungi, and lichens of Professor Setchell are deposited with the Botanical Department, and are accessible to advanced students.

*Publication.*—Short papers may be published in *Erythea*, a monthly journal edited by Mr. Jepson.

Longer papers and monographs requiring expensive plates may be published in the botanical volumes of *Proc. Cal. Acad. Sci.*, of which Professor Setchell is one of the editors.

#### THE UNIVERSITY OF CHICAGO.

*Staff.*—John M. Coulter, Ph.D., Head Professor; Edwin O. Jordan, Ph.D., Assistant Professor of Bacteriology; Bradley M. Davis, Ph.D., Instructor; Charles J. Chamberlain, A.M., Assistant; four Fellows who are members of the instruction force.

*Subjects offered.*—1. Special morphology of spermatophytes.—Professor COULTER.

2. Special morphology of algæ.—Dr. DAVIS.

3. Ecology, especially with reference to the problems of the dunes.—Professor COULTER.

4. Taxonomy of any group of spermatophytes.—Professor COULTER.

5. Bacteriology.—Dr. JORDAN.

*Library.*—General library 310,000 volumes, 180,000 pamphlets. The strictly botanical library contains about 3000 vol-



umes, including complete sets of numerous periodicals, and several thousand pamphlets (not yet catalogued). The Newberry and Crerar libraries, both easily reached, add largely to the library facilities. A very complete list of current books and periodicals is received in exchange for the BOTANICAL GAZETTE.

*Greenhouses and garden.*—There are no greenhouses at present belonging to the university. The large houses in Washington Park, and the extensive planting both in Jackson and Washington parks (a few blocks east and west of the university respectively) supply almost unlimited material.

*Collections.*—The entire herbarium and library of Head Professor Coulter have been purchased by the university, containing a very full representation of the vascular plants of North America, and their literature. The collection is especially rich in types and standard sets.

*Publication.*—The BOTANICAL GAZETTE, published by the university, is the natural avenue for publication of papers from the department. Books may be issued by The University of Chicago Press.

*Remarks.*—A botanical club holds weekly meetings to discuss current research and publications.

The foregoing relates only to work offered this year. Enlarged space, facilities and staff, will be provided after the completion of the Hull Botanical Laboratory, now in course of construction.

#### COLUMBIA UNIVERSITY.

*Staff.*—Lucien M. Underwood, Ph.D., Professor; Carlton C. Curtis, Ph.D., Tutor; J. K. Small, Ph.D., curator of herbarium.

*Subjects offered.*—1. Anatomy and morphology both of spermatophytes and cryptogams. 2. Taxonomic work in nearly all groups. 3. Palæobotany, offered by the department of Geology.

*Library.*—General library, 225,000 volumes. The botanical portion contains about 4000 volumes and 5000 pamphlets shelved in herbarium room, besides general scientific series and serials containing botanical matter accessible in the general library.



The library of the New York Academy of Sciences, very rich in general scientific serials, is one floor above the herbarium.

The university collection contains almost complete files of nearly every serial ever published on botany, besides general works and special works. The cryptogamic portion is especially full on ferns, mosses, hepatics, lichens, and fungi.

*Greenhouses and garden.*—A greenhouse at Morningside, with some facilities for supplying living plants and space for simple physiological research. On future facilities, see below.

*Collections.*—(a) The herbarium contains about 600,000 specimens, being one of the largest in America; additions are at present made to it at the rate of about 20,000 specimens a year. It comprises: (1) The collections accumulated by Dr. Torrey, which came into the possession of the university at his death in 1873. (2) The collections of Professor C. F. Meisner, of Basle, Switzerland, presented to the university about the time of Dr. Torrey's death, by Mr. John J. Crooke. (3) The collections of Dr. A. W. Chapman, of Apalachicola, Florida, presented by Mr. Crooke at the same time, containing the types illustrating Dr. Chapman's "Flora of the Southern United States." (4) The mosses of the late C. F. Austin. (5) The mosses of the late Dr. J. G. Jaeger, recently acquired. (6) The fungi of J. B. Ellis, about 75,000 specimens, recently acquired for the New York Botanical Garden; in addition there are about 25,000 specimens of fungi in the general collections. (7) Miscellaneous accumulations since Dr. Torrey's death, now making up more than one-third of the whole collection. The herbarium is rich in types of species described by Dr. Torrey, Professor Meisner, Dr. Chapman, Dr. Asa Gray, Mr. Austin, Professor Britton, and Dr. Morong. The various collections are now all arranged in a single series, but each sheet is identified by a designative label or stamp. There are also extensive collections of fruits, seeds, woods, and material illustrating economic botany, placed in cases and drawers.

(b) The Jesup collection of woods in the American Museum of Natural History.



(c) Extensive economic collections and the Canby and Wood herbaria at the New York College of Pharmacy under the supervision of Professor Rusby.

(d) The Morong herbarium at Barnard College.

*Publication.*—The *Bulletin* and the *Memoirs* of the Torrey Botanical Club, and the *Transactions*, the *Annals*, and the *Memoirs* of the New York Academy of Sciences offer opportunities for papers; the University Press of Columbia University will issue books.

*Remarks.*—After the completion of the museum building of the New York Botanical Garden, the graduate research work will be conducted at that place where all the botanical facilities are to be centered.

#### CORNELL UNIVERSITY.

*Staff.*—George F. Atkinson, Ph.B., Professor; W. W. Rowlee, Sc.D., Assistant Professor; E. J. Durand, Sc.D., Instructor; K. M. Wiegand, B.S., Assistant; B. M. Duggar, A.M., Assistant.

*Subjects offered.*—1. Experimental morphology; with special reference to (1) sterilization of sporogenous tissue, (2) transformation of sporophylls, (3) homology of plant members, (4) teratological questions.

2. Experimental physiology, with special reference to the measurement of osmotic pressures.

3. Ecology, with special reference to relation and distribution of plants under peculiar conditions in central New York; distribution of fungi on hosts.

4. Comparative embryology; (1) embryology of sporophytic organs; (2) embryology of gametophytic organs; (3) accompanying cytological problems.

5. Morphology of fungi; monographic studies of certain genera.

6. Development of fungi; special and comparative studies of genera.

7. Structure and development of algæ; special facilities for the study of cystocarpic development in Florideæ.



8. Cytology in the broad sense.

9. Comparative histology; with special reference to development of vascular tissue, and secondary thickening of the cambium; tissues of seedlings; relation of histology to taxonomy.

10. Special morphology of higher plants, with reference to special forms assumed by different members.

*Library.*—General library contains 190,000 volumes and 50,000 pamphlets. A large number of current journals are received. Botany has a good showing in the library, but it would be impossible to give an accurate or even approximate statement since so many of the important articles are found in transactions and proceedings of societies.

*Greenhouses and garden.*—Five different houses of different temperatures, with a variety of exotic plants, some native plants, space for growing plants in physiological experiments, and material for illustration and use in the laboratories.

A garden for illustrations and for growing plants, to supply certain of the wants in the laboratory, as well as for experimental purposes.

*Collections.*—A small but growing herbarium of about 15,000 species.

#### HARVARD UNIVERSITY.

*Staff.*—George L. Goodale, M.D., LL.D., Professor Nat. Hist. and Director of Botanic Garden; Wm. G. Farlow, M.D., LL.D., Prof. Crypt. Bot.; Roland Thaxter, Ph.D., Asst. Prof. Crypt. Bot.; H. L. Jones, A.M., Instructor; Arthur B. Seymour, M.S., Asst. in Crypt. Herb.; Albert R. Sweetser, A.M., Asst.; Frederick O. Grover, A.B., Asst.; Jos. W. Blankinship, Asst.

*Subjects offered.*—1. Structure and development of phanerogams. 2. Physiology. 3. Taxonomy of pteridophytes and phanerogams. 4. Economic and medical botany.—Professor GOODALE.

5. Structure and development of cryptogams.—Professors FARLOW and THAXTER.



In the case of candidates for degrees, who are generally young men just beginning their botanical career, it has been the practice in the cryptogamic laboratories to set them to work on some histological or developmental subject rather than upon descriptive systematic work; it being the opinion that, while a beginner may be able to accomplish something valuable in the first-named field, purely systematic work worthy of publication cannot be expected except after a number of years have given a broad, practical knowledge and matured the judgment. In the case of candidates for a degree, students are allowed to select subjects in accordance with their individual tastes, provided such subjects can be properly worked up in the two or three years of candidacy.

Besides candidates for the doctor's degree, the university offers the means for research to persons specially qualified who reside at the university, for the purpose of pursuing some special piece of work. These are in general visiting botanists and specialists who remain for periods varying from a few days to a few months, and they are often occupied with systematic work; to such persons the libraries are freely accessible, and they are allowed to consult the herbaria under the charge of the curators.

*Library.*—The general library of the university contains 468,000 volumes and 450,000 pamphlets. Students have free access to the large special botanical libraries in Cambridge and Boston and the private libraries of the instructors. The former furnish valuable series of journals and proceedings and the latter special papers and monographs. The special library at the Gray Herbarium contains 9000 volumes and pamphlets.

*Greenhouses and garden.*—The greenhouses are located at the Botanic Garden, half a mile from the general laboratories. Special laboratories are available at the garden, when desired. The plant houses are arranged for various temperatures and conditions.

The garden embraces seven acres fully planted, and contains over 5000 species.



*Collections.*—If the material to be studied is histological, the student is provided with alcoholic, or dried material, of which a considerable amount is kept on hand to illustrate certain points which sooner or later should be investigated. If the subject requires living material, the country near Cambridge and the seashore furnish abundant material.

The herbaria at the museum are rich in fungi, algæ and lichens, and at the Gray Herbarium are valuable collections of higher cryptogams and mosses. The lichens include the Tuckerman collection together with a number of other native and exotic collections; the fungi include the Curtis collection and a large series of published exsiccati; and the algæ are represented by several valuable foreign collections and exsiccati, besides the large collection of American algæ.

There are extensive collections of economic products in the museum.

The Gray Herbarium of over 200,000 sheets, and rich in types, affords extraordinary opportunity for research in phanerogamic taxonomy. It also contains several important collections of mosses.

*Remarks.*—A botanical club holds fortnightly meetings.

The staff of the Gray Herbarium is not included above, as its duties are not primarily instructional.

#### UNIVERSITY OF ILLINOIS.

*Staff.*—T. J. Burrill, Ph.D., LL.D., Professor; G. P. Clinton, M.S., Instructor; C. F. Hottes, M.S., Assistant.

*Subjects offered.*—1. Taxonomy of fungi and fresh water algæ. 2. Bacteriology. 3. Histology. 4. Physiology.

*Library.*—General library of 28,200 volumes and 6200 pamphlets contains about 2000 volumes strictly botanical. Includes complete sets of all the prominent European and American periodicals (save the English illustrated and expensive publications), and most of the standard works on physiological, pathological and economic subjects. The fungi are especially well represented.



*Greenhouses and garden.*—There is no garden. Greenhouses on the university grounds contain plants of many kinds, not collected for any particular line of study. The facilities of the houses for propagation, growth in pots, etc., are available. Attached to the laboratory for vegetable physiology is a small conservatory 14 × 19 ft., two stories high, with aquarium tank 6 × 14 ft. in lower room.

*Collections.*—The herbarium is small (about 25,000 species, mounted) but is rich in parasitic fungi. There is a very nearly complete set of Illinois flowering plants and ferns. The grasses are well represented.

*Remarks.*—A biological station established at Havana, Ill., on the Illinois river, contributes special facilities for investigations upon aquatics.

#### JOHNS HOPKINS UNIVERSITY.

*Staff.*—J. E. Humphrey, S.D., Lecturer.

*Subjects offered.*—Morphology.

*Library.*—The library of Capt. John Donnell Smith (which has been offered to the university) is near by and is accessible to properly prepared students. It is rich in the literature of the taxonomy of spermatophytes, and in serials.

Besides this library, those of the neighboring Peabody Institute, of the university (76,000 volumes and 55,000 pamphlets), and of the instructor, contain much important botanical literature. Altogether, the most important books, full sets of nearly all the journals, and of the proceedings of the chief learned societies are readily accessible.

*Greenhouses and garden.*—None.

*Collections.*—The collections in the care of the university are small, comprising the Schimper herbarium of European and African phanerogams, the local collections of the Naturalists' Field Club, the Fitzgerald collection of mosses, and the private herbarium of the instructor, chiefly of thallophytes. The herbarium of Capt. Smith is also accessible to students.

*Remarks.*—Graduate work in botany is a matter of recent



development at the Johns Hopkins University, and the number of students who can be accommodated is limited.

#### LELAND STANFORD JUNIOR UNIVERSITY.

*Staff.*—Douglas H. Campbell, Ph.D., Professor; Wm. R. Dudley, M.S., Professor; Walter R. Shaw, A.M., Instructor.

*Subjects offered.*—Life-history of one of the lower monocotyledons, hepatics, or pteridophytes; comparative organogeny; special problems in cytology; systematic study of special groups of native plants.

*Library.*—The university library consists of 30,000 volumes, and 10,000 pamphlets. In botany it contains standard works of general character up to date, and complete sets of several of the more important journals. It is supplemented by private libraries of professors, especially rich in separates pertaining to special subjects.

*Greenhouses and garden.*—There are two greenhouses on the grounds, but not conveniently situated, so that they are little used. Material is chiefly derived from the wealth of vegetation growing out of doors, both wild and cultivated. The university tract of 8000 acres embraces a great variety of surface, and furnishes an abundance of materials of all sorts. Extensive plantations of exotic and native plants, including a great variety of trees and shrubs, offer unusual opportunities. Moreover, the mountains and seashore are both readily accessible.

*Collections.*—The herbarium now contains about 25,000 species. The collections and library of the California Academy of Sciences at San Francisco (33 miles away) are also available.

*Remarks.*—The Hopkins seaside laboratory at Pacific Grove, an adjunct of the biological department of the university, offers especially good facilities for the study of the rich marine flora.

#### UNIVERSITY OF MICHIGAN.

*Staff.*—Volney M. Spalding, Ph.D., Professor; F. C. Newcombe, Ph.D., Assistant Professor; J. O. Schlotterbeck, Ph.D.,



Assistant Professor; Jas. B. Pollock, M.S., Assistant; Fannie E. Langdon, B.S., Assistant.

*Subjects offered.*—Morphology. Physiology.

*Library.*—General library contains 100,000 volumes, 18,000 pamphlets. The special botanical books are shelved in the laboratory. They comprise sets of journals and other periodical literature and monographs.

*Greenhouses and garden.*—Space is provided in a neighboring conservatory and garden where plants under investigation are cared for by an attendant.

*Collections.*—The laboratory contains a large collection of alcoholic material and an herbarium of about 100,000 sheets representing about 14,000 species. The collection of fungi includes Ellis and Everhart, Briosi and Cavara and other valuable sets, and a large representation of species occurring in Michigan. Arrangements are also made by which abundant marine and tropical material is provided when needed.

*Remarks.*—The income of the laboratory makes it possible to promise an investigator anything that he really needs in the way of material and apparatus.

A journal club of a dozen or fifteen instructors, investigators, and advanced students meets weekly for reports on current literature.

#### UNIVERSITY OF MINNESOTA.

*Staff.*—Conway MacMillan, A.M., Professor; D. T. MacDougal, A.M., M.S., Assistant Professor; F. Ramaley, M.S., Instructor; A. A. Heller, Instructor; Josephine E. Tilden, B.S., Instructor.

*Subjects offered.*—Comparative morphology, anatomy and embryology; ecology; cytology; algology and mycology; ecologic distribution.

Taxonomy of Spermatophyta and Pteridophyta.

Physiology, with special reference to irritability, the directive and formative influence of environmental factors.

Special research. Students with expert knowledge are



encouraged to select special problems and carry them along to some useful and adequate solution. For such investigations it is the policy of the institution to provide any reasonable facility in the way of special apparatus, material and literature. The university does not hesitate at expense if there be the opportunity of developing some important research under its supervision.

*Library.*—The general botanical library contains about 2200 bound volumes and 3800 separates. Especial care has been exercised to procure complete sets of periodicals, and practically all the important botanical journals, with the exception of *Curtis' Magazine*, *Oesterreichische Botanisches Zeitschrift* and *Nuovo Giornale Botanico Italiano*, have been purchased entire or are easily available. Certain special fields are well represented in the collection, but it is the plan of the department to furnish exhaustive series of literature only when a definite problem is to be settled. Of course all the botanical bibliographies are at hand, and there is absolutely no reason in any given case why everything that has been done upon any given topic should not be brought to light.

The physiological section includes about 200 volumes and 1000 separates shelved in the laboratory. Literature not purchasable may be obtained by loan from a German institute by a personal arrangement of the instructor.

The mycological and algological collections are likewise shelved in the respective laboratories, and a large section of the taxonomic library is shelved in the herbarium.

*Collections.*—Besides several hundred specimens of wood from different parts of the world and as many jars of alcoholic and formalose material, the herbarium with its 200,000 specimens (in round numbers) is an important part of the equipment. It is being developed upon the broadest basis. Plants of all orders and from every part of the world are either already included in its cases or are among its desiderata. It now serves as a very adequate reference collection for North American taxonomy and is rich also in Mexican, European, African, and Asiatic material.



It continues to increase rapidly in size and value and, as in the library, efforts will be made to supply as full an illustrative series of plants as possible, for whatever special research may be taken up.

*Greenhouses and garden.*—The plant house (20×40 feet) is inadequate at present but suffices for the maintenance of some 300 species of plants that are used in morphological work. Besides its further function as an adjunct to the laboratory of plant physiology, its principal use is as a depot for native plants freshly taken from their stations. There is no garden.

*Publication.*—*Minnesota Botanical Studies*, a quarterly or occasional series of papers, offers a medium of publication for the researches of the department. Plates are provided as needed and separates are struck off when requested.

*Remarks.*—In morphology and ecology the university offers to a limited number of graduate students every facility desired in the way of instruments, reagents, literature and material. There are accommodations at present for twenty. Problems in cytology, in embryology, and in anatomy are particularly kept in mind by the instructor. Special laboratories, three in number, are at the disposal of graduates in these lines. Collecting trips to different parts of the state can be arranged; cameras are provided for ecologic work, and camping outfits are furnished those who desire to spend some time in the field.

The department is prepared to assist in the taxonomic revision of any North American genus or family, and either has or will procure a full set of material for study. An exchange bureau is maintained in connection with the herbarium, through the correspondence of which a large number of American collectors can be reached.

The accommodations in physiology are sufficient for six students. The instructor has in hand notes and material upon which a student may profitably engage in the investigation of certain problems in the formative and directive influence of external factors, irritability to contact and impact, transmission of impulses, curvatures, growth correlations, and the physiology



of storage tissues and color layers. Beside the usual physiological apparatus, a number of pieces of more or less complex apparatus of special design, which were constructed for the solution of problems under investigation, have been accumulated. Such appliances are often found to be of very great value in other work. New and necessary apparatus may be purchased, and that designed by the investigator can be made very promptly by the instrument makers to the electrical and physical departments.

#### THE UNIVERSITY OF NEBRASKA.

*Staff.*—Charles E. Bessey, Ph.D., Professor; Frederic E. Clements, B.S., First Assistant; Cornelius L. Shear, Second Assistant; Edna L. Hyatt, Botanical Artist.

*Subjects offered.*—1. Plant morphology. Work in several lines of morphology has been given successfully for several years.

2. Systematic botany *A*, being the study of a selected group of plants. Here the student will find ample material for the study of all the important groups (classes, most orders, and many families). The herbarium has been built up in such manner as to represent as fully as possible all the important groups.

3. Systematic botany *B*, being the study of a local flora, and the preparation of a catalogue. The plains, and the mountains to the west, afford ample facilities for this work, supplemented by the quite full herbarium of the Botanical Survey of the state.

4. Phytogeography. The collections made by the Botanical Seminar afford ample material for profitable study.

*Library.*—The university library contains 34,000 volumes, and the botanical library about 2000. In the university library 467 periodicals are received, in the botanical library 43. Of many of these it has complete sets; of others its files run back ten or twelve years; while of still others the files are but a few years old.

*Greenhouses and garden.*—There is a steam-heated greenhouse of 4200 sq. ft. of glass, with tank for aquatics; no garden.



*Collections.*—The herbarium contains from 70,000 to 80,000 specimens, and includes exsiccatae by Wittrock and Nordstedt, Rabenhorst, Le Jolis, Ellis and Everhart, Thueman, M. A. Curtis, Romell, Linhart, Sydow, Shear, Seymour, Tuckerman, Stenhamer and Fries, Massalongo, Seymour and Cummings, Gottsche and Rabenhorst, Austin, Underwood and Cook, Heller, A. H. Curtiss, Harvey, Rydberg, etc. The quite complete herbarium of the Botanical Survey of Nebraska, by the Botanical Seminar, is also available for study.

*Publication.*—Ample opportunity for publication is afforded by "Contributions from the Botanical Department of the University of Nebraska," "Bulletin of the University Experiment Station," "University Studies," "Reports of the Botanical Survey," and "Flora of Nebraska." The two last are published by the Botanical Seminar.

*Remarks.*—A shop for the construction of apparatus is equipped with tools, lathe, anvils, etc.

The Botanical Seminar is a very active organization, largely interested in the study of the state flora. At its bimonthly meetings botanical papers are read and critically discussed. Admission to membership is attained upon passing an examination in the anatomy and morphology of the spermatophytes, morphology and development of the lower plants, embryology of spermatophytes, taxonomy, bibliography, etc.

#### PURDUE UNIVERSITY.

*Staff.*—Stanley Coulter, Ph.D., Professor of Biology; J. C. Arthur, Sc.D., Professor of Physiological and Pathological Botany; Katherine E. Golden, M.S., Instructor in Biology; Severance Burrage, B.S., Instructor in Bacteriology; William Stuart, B.S., Assistant.

*Subjects offered.*—Histology; taxonomy of spermatophytes.—Professor COULTER. Physiology; ecology; pathology.—Professor ARTHUR. Bacteriology.—Mr. BURRIDGE.

Graduate work in these subjects is carried on with accom-



modations provided jointly by the university and the Agricultural Experiment Station.

*Library.*—The botanical resources of the university library (8000 volumes) are only moderate. The private library of the professor of physiological botany, kept at his residence, contains about 800 bound volumes and 2000 pamphlets, and is especially rich in works on physiology, pathology and fungi. The works have been purchased as need for them arose, and additions are being constantly made. It is open freely to the use of students.

The botanical part of the library of the station is also available, and consists of about 200 volumes, of which about one-half is embraced in nearly or wholly complete sets of *Berichte der deutschen botanischen Gesellschaft*, *Botanisches Centralblatt*, *Centralblatt für Bakteriologie und Parasitenkunde*, and Just's *Botanischer Jahresbericht*.

*Greenhouses and garden.*—From the general laboratory a door opens directly into the greenhouse, which may be considered as a glass covered portion of the laboratory, being on the same level, with tight floor and table topped benches. The greenhouse is small, but is entirely devoted to research work, the usual collection of conservatory plants being almost wholly excluded. It is in two independent parts, permitting different degrees of temperature to be maintained. The university conservatories, not far away, contain a good general assortment of plants, which may be drawn upon if required.

The garden has but a temporary value, and consists of a plot of ground a few steps from the laboratory, having a few shrubs and perennials, but available for the accumulation or cultivation of plants required for an investigation. The glass covered vegetation house is 20×50 feet, but is serviceable chiefly for summer work.

*Collections.*—The herbarium of the biological department contains about 6500 mounted sheets of phanerogams, and is especially rich in the plants of Indiana. The herbarium of the professor of physiology, including probably six thousand species, is only in small part readily accessible, being unmounted. The



mounted part consists of about 1300 sheets of phanerogams and 1600 sheets of fungi, nearly three-fourths of the latter being Uredineæ.

*Publication.*—The *Bulletin* of the Agricultural Experiment Station has provided for the publication of research work.

*Remarks.*—A machine room, provided with a lathe and assortment of iron and woodworking tools, and a skilled mechanic when required for making needed apparatus, is maintained.

#### SMITH COLLEGE.

*Staff.*—William F. Ganong, Ph.D., Professor; Grace D. Chester, B.S., Instructor in Cryptogamic Botany.

*Subjects offered.*—Morphology; ecology.

*Library.*—Contains all ordinary reference works; is being strengthened rapidly, particularly in morphology and ecological phases of physiology. The Forbes Library, richly endowed, practically on the college grounds, buys the more expensive works if not too technical. Amherst Agricultural College library (seven miles away with railroad between) is rich in complete sets of botanical and agricultural journals and proceedings, and is accessible freely to all students.

*Greenhouses and garden.*—The college possesses a garden, with systematic and ecological sections being rapidly developed. Some 800 species are in cultivation out of doors. There is a nursery available for experiment. The range of greenhouses is in every respect thoroughly efficient, and fairly stocked, particularly with plants selected to illustrate morphological and ecological principles. Includes (*a*) experiment house 20 × 30 ft. with special stages directly on brick piers; attached to it is a small laboratory 20 × 15 ft.; (*b*) cool temperate house 20 × 30 ft.; (*c*) acacia and succulent house, 20 × 17 ft.; (*d*) palm house 56 × 35 × 25 ft. high; (*e*) tropical house 32 × 20 ft.; (*f*) warm temperate and aquatic house 45 × 20 ft., propagating house 5 × 60 ft., working house, etc. The entire range is exclusively for botanical purposes, and any part of it and its stock is



available for investigation, and materials therefore can be grown in any quantity and with all proper conditions.

*Collections.*—The herbaria are small; the phanerogams just under 4000 sheets; the cryptogams 2500; both general.

*Remarks.*—Smith College does not especially encourage graduate work at present, as it is devoting its main resources to strengthening its undergraduate course in all directions. Nevertheless it does not decline to receive graduate students and it confers the Ph.D. degree upon the conditions usual in institutions of the first rank.

#### UNIVERSITY OF WISCONSIN.

*Staff.*—Charles R. Barnes, Ph.D., Professor of Botany; H. L. Russell, Ph.D., Professor of Bacteriology; L. S. Cheney, M.S., Assistant Professor of Pharmaceutical Botany; W. S. Marshall, Ph.D., Assistant Professor of Biology; W. D. Frost, Assistant in Bacteriology.

*Subjects offered.*—1. Physiology, especially nutrition; Bryology.—Professor BARNES.

2. Agricultural and Dairy Bacteriology.—Professor RUSSELL.

3. Histology, especially of medicinal plants.—Professor CHENEY.

*Library.*—The university library is deficient in many respects. It contains about 45,000 volumes and 10,500 pamphlets, of which about 1000 and 200 respectively are especially botanical, including full sets of many important periodicals. Such as are most used are shelved at laboratories. It is quite complete in the taxonomy of bryophytes. It is supplemented by the libraries of the State Historical Society and the Academy of Sciences, Arts, and Letters (about 200,000 volumes and pamphlets), which contain many sets of transactions, etc., and some of the expensive general works; and by the private libraries of the professors, containing many separates.

*Greenhouses and garden.*—The physiological laboratory opens into a small conservatory 9 × 18 ft. for experimental work only. Large greenhouses belonging to the Agricultural Department



supply growing material at all seasons, but are too far away (half a mile) for direct use. There is no garden. About four acres of campus, a hundred yards from laboratory, are kept in original wild state with native trees and undergrowth and supply material during the growing season. Adequate supplies of alcoholic and formalin specimens are kept for research in histology and morphology.

*Collections.*—The general herbarium contains about 10,000 species. Special attention is given only to building up the herbarium of Wisconsin plants and of North American mosses. The latter is almost complete and has many sets of exsiccati.

*Publication.*—The *Bulletin* of the university of Wisconsin, Science Series, and the *Bulletin* of the Agricultural Experiment Station afford special facilities for publication.

*Remarks.*—The university creamery furnishes unusual opportunities for research in dairy bacteriology upon a commercial scale. A journal club holds weekly meetings.